

Name \_\_\_\_\_ Period \_\_\_\_\_

**Chapter 2: The Chemical Context of Life**

This chapter covers the basics that you may have learned in your chemistry class. Whether your teacher goes over this chapter or assigns it for you to review on your own, the questions that follow should help you focus on the most important points.

**Concept 2.1 Matter consists of chemical elements in pure form and in combinations called compounds**

1. Define and give an example of the following terms:

**matter**

**element**

**compound**

2. What four elements make up 96% of all living matter?
3. What is the difference between an *essential element* and a *trace element*?

**essential element**

**trace element**

**Concept 2.2 An element's properties depend on the structure of its atoms**

4. Sketch a model of an atom of helium, showing the electrons, protons, neutrons, and atomic nucleus.
5. What is the atomic number of helium? \_\_\_\_\_ What is the atomic mass? \_\_\_\_\_
6. Here are some more terms that you should firmly grasp. Define each term.

**neutron**

**proton**

**electron**

**atomic number**

**atomic mass**

**isotope**

**electron shells**

**energy**

7. Consider the entry in the periodic table for carbon, shown below.

What is the atomic mass? \_\_\_\_\_ What is the atomic number? \_\_\_\_\_

How many electrons does carbon have? \_\_\_\_\_ How many neutrons? \_\_\_\_\_

6
C
12

8. What are *isotopes*? Use carbon as an example in your explanation.
9. Explain radioactive isotopes and one medical application that uses them.
10. What is the only subatomic particle that is directly involved in the chemical reactions between atoms?
11. What is *potential energy*?
12. Explain which has more potential energy in each pair:
- boy at the top of a slide/boy at the bottom
  - electron in the first energy shell/electron in the third energy shell
  - water/glucose
13. What determines the chemical behavior of an atom?
14. Here is an electron distribution diagram for sodium:



- How many valence electrons does it have? \_\_\_\_\_ Circle the valence electron(s).
- How many protons does it have? \_\_\_\_\_

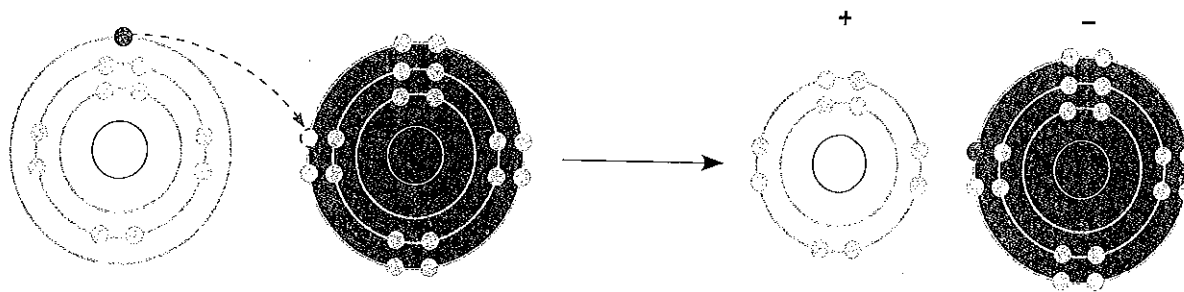
**Concept 2.3 The formation and function of molecules depend on chemical bonding between atoms**

15. Define *molecule*.

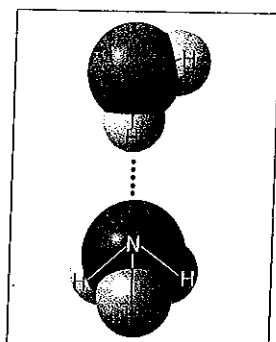
16. Now, refer back to your definition of a *compound* and fill in the following chart:

	Molecule? (y/n)	Compound? (y/n)	Molecular Formula	Structural Formula
Water				
Carbon dioxide				
Methane				
O <sub>2</sub>			O <sub>2</sub>	

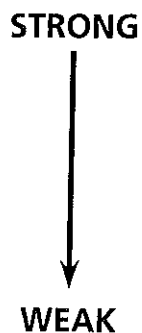
17. What type of bond is seen in O<sub>2</sub>? Explain what this means.
18. What is meant by *electronegativity*?
19. Explain the difference between a *nonpolar covalent bond* and a *polar covalent bond*.
20. Make an electron distribution diagram of water. Which element is most electronegative? Why is water considered a *polar molecule*? Label the regions that are more positive or more negative. (This is a very important concept. Spend some time with this one!)
21. Another bond type is the *ionic bond*. Explain what is happening in the following figure (Figure 2.14 in your text):



22. What two elements are involved in the previous figure?
23. Define *anion* and *cation*. In the preceding example, which is the anion?
24. What is a *hydrogen bond*? Indicate where the hydrogen bond occurs in the following figure.



25. Explain *van der Waals interactions*. Though they represent very weak attractions, when these interactions are numerous they can stick a gecko to the ceiling!
26. Here is a list of the types of bonds and interactions discussed in this section. Place them in order from the strongest to the weakest: hydrogen bonds, van der Waals interactions, covalent bonds, ionic bonds.



27. Use morphine and endorphins as examples to explain why molecular shape is crucial in biology.

**Concept 2.4 Chemical reactions make and break chemical bonds**

28. Write the chemical shorthand equation for photosynthesis. Label the *reactants* and the *products*.
29. For the equation you just wrote, how many molecules of carbon dioxide are there? \_\_\_\_\_  
How many molecules of glucose? \_\_\_\_\_ How many elements in glucose? \_\_\_\_\_
30. What is meant by *dynamic equilibrium*? Does this imply equal concentrations of each reactant and product?

*Test Your Understanding Answers*

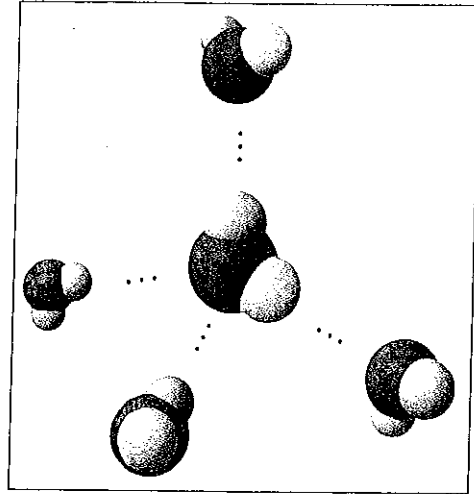
Now you should be ready to test your knowledge. Place your answers here:

1. \_\_\_\_\_ 2. \_\_\_\_\_ 3. \_\_\_\_\_ 4. \_\_\_\_\_ 5. \_\_\_\_\_ 6. \_\_\_\_\_  
7. \_\_\_\_\_ 8. \_\_\_\_\_

Name \_\_\_\_\_ Period \_\_\_\_\_

**Chapter 3: Water and Life****Concept 3.1 Polar covalent bonds in water result in hydrogen bonding**

1. Study the water molecules at the right. On the central molecule, label oxygen (O) and hydrogen (H).
2. What is a *polar molecule*? Why is water considered polar?
3. Now, add + and – signs to indicate the charged regions of *each* molecule. Then, indicate the hydrogen bonds.
4. Explain *hydrogen bonding*. How many hydrogen bonds can a single water molecule form?

**Concept 3.2 Four emergent properties of water contribute to Earth's suitability for life**

Hydrogen bonding accounts for the unique properties of water. Let's look at several.

**Cohesion, Adhesion, and Surface Tension**

5. Distinguish between *cohesion* and *adhesion*.
6. Which property is demonstrated when you see beads of water on a waxed car hood?
7. Which property explains the ability of a water strider to walk on water?

**Moderation of Temperature**

8. The calorie is a unit of heat. Define *calorie*.
9. Water has high *specific heat*. What does this mean? How does water's specific heat compare to alcohol's specific heat?
10. Explain how hydrogen bonding contributes to water's high specific heat.
11. Summarize how water's high specific heat contributes to the moderation of temperature. How is this property important to life?

12. Define *evaporation*. What is *heat of vaporization*? Explain at least three effects of this property on living organisms.

### Expansion upon Freezing

13. Ice floats! So what? Consider what would happen if ponds and other bodies of water accumulated ice at the bottom. Describe why this property of water is important.
14. Now, explain *why* ice floats. Why is 4°C the critical temperature?

### Solvent of Life

15. Review and define these terms:

**solvent**

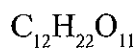
**solution**

**solute**

16. Consider coffee to which you have added sugar. Which of these is the solvent? Which is the solute?
17. Explain why water is such a fine solvent.
18. Distinguish between *hydrophobic* and *hydrophilic substances*. Give an example of each.
19. You already know that some materials, such as olive oil, will not dissolve in water. In fact, oil will float on top of water. Explain this property in terms of hydrogen bonding.
20. Now, let's do a little work that will enable you to prepare solutions. Read the section on solute concentrations carefully, and show the calculations here for preparing a 1-molar solution of sucrose. Steps to help you do this follow. The first step is done for you. Fill in the rest.

#### Steps to prepare a solution:

- a. Write the molecular formula.



- b. Use your periodic table to calculate the mass of each element. Multiply by the number of atoms of the element. (For example, O has a mass of 16. Therefore, one mole of O has a mass of  $16 \times 11 = 176$  g/mole.)

- c. Add the masses of each element in the molecule.
- d. Add this mass of the compound to water to bring it to a volume of 1 liter. This makes 1 liter of a 1 *M* (1-molar) solution.

21. Can you prepare 1 liter of a 0.5-molar *glucose* solution? Show your work here.

22. Define *molarity*.

**Concept 3.3 Acidic and basic conditions affect living organisms**

23. What two ions form when water dissociates?

You should have answered “hydronium ( $\text{H}_3\text{O}^+$ ) and hydroxide ions ( $\text{OH}^-$ )” in the preceding question. However, by convention, we will represent the hydronium ion as  $\text{H}^+$ .

24. What is the concentration of each ion in pure water at 25°C?

25. Water has a pH of 7. *pH* is defined as the negative log of the hydrogen ion concentration  $[\text{H}^+]$ . Can you now see how water is assigned a pH of 7?

26. To go a step further, the product of  $\text{H}^+$  and  $\text{OH}^-$  concentrations is constant at  $10^{-14}$ .

$$[\text{H}^+][\text{OH}^-] = 10^{-14}$$

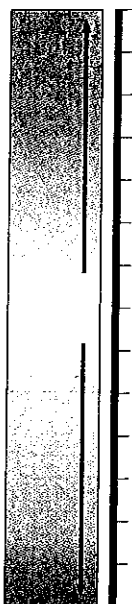
Water, which is neutral with a pH of 7, has an equal number of  $\text{H}^+$  and  $\text{OH}^-$  ions. Now, define

**acid**

**base**

27. Because the pH scale is logarithmic, each numerical change represents a 10X change in ion concentration.

- a. How many times more acidic is a pH of 3 compared to a pH of 5?
- b. How many times more basic is a pH of 12 compared to a pH of 8?
- c. Explain the difference between a pH of 8 and a pH of 12 in terms of  $\text{H}^+$  concentration.



28. On the pH chart, label pH 1–14. Label *neutral*, *acid*, and *base*. Indicate the locations of pure water, urine, gastric juice, and bleach.

29. Even a slight change in pH can be harmful! How do *buffers* moderate pH change?

30. Exercise will result in the production of  $\text{CO}_2$ , which will acidify the blood. Explain the buffering system that minimizes blood pH changes.

31. *Acid precipitation* is increasing. What is the pH of uncontaminated rain?

32. Give two reasons precipitation is more acidic today compared to 1900.

33. What products of fossil fuel burning contribute to acid precipitation?

34. Discuss how  $\text{CO}_2$  emissions affect marine life and ecosystems.

*Test Your Understanding Answers*

Now you should be ready to test your knowledge. Place your answers here:

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7. \_\_\_\_\_ 8. \_\_\_\_\_